

Rockwell (A.D.)

THE INDUCTION COIL:

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*Varieties and the Differential Indications
for their Use.*

BY

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NEW YORK.



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THE INDUCTION COIL—ITS VARIETIES AND THE DIFFERENTIAL INDICATIONS FOR THEIR USE.¹

WHEN solicited to contribute something to the annual meeting of this Academy along that line of research in which I have been interested for so long a time, I hesitated in the selection of a topic. Of material there is plenty, and of sufficient importance. The whole field of the physics, physiology, and therapeutics of electricity lies open before us. The comparative value of its three subdivisions offers a subject for discussion and the relation of experiences, while the differential indications for the use of these various forms—galvanism, faradism, and franklinism—is of still greater importance and even less understood.

Vital in interest as are each and all of these themes, and others that occurred to my mind, they seemed to be excluded from discussion here, since it has been suggested that whatever is presented should flavor somewhat of originality, or at least be not altogether hackneyed; and these topics have, one and all, been discussed at various times in the current medical literature of the day, and are more or less fully considered in many of the works devoted to electro-therapeutics. The laudable aspiration of this Academy, then, as attested by the prospectus lately issued, confirms the aphorism that “originality is a thing we constantly clamor for,” as well as “constantly quarrel with.” Unfortunately, how-

¹ Read before the annual meeting of the American Academy of Medicine, at Baltimore, October 28, 1884.

ever, pure originality in thought or methods of expression is the gift of but few. Old and long-forgotten ideas are being constantly rehabilitated and brought forward under the guise of new and advanced opinions. In this way, much that would otherwise be lost or fall short of its proper utilization becomes, through a more persistent and perhaps clearer presentation, a practical part of the world's integral store of knowledge. While, therefore, none of the facts in physics that I propose here to present are in any sense new, yet there has been no general appreciation of them, and but little knowledge, even among those who have been endeavoring, in a blind sort of way, to utilize them, that such facts existed.

As to the few statements that are made along the line of therapeutics, the most that I can say of them is that they are the result of much experience and of very many carefully recorded observations, and if presented with any measure of clearness ought to be of some little service to those who are interested in but who have given little thought to the matter. But to my theme. There are two kinds of electro-magnetic machines that are presented to the medical men for therapeutic purposes. The first is termed a *separate* coil, and the second a *continuous or single* coil apparatus. The separate coil apparatus is the one most commonly used and the one most generally understood. The separate coil is the variety described and illustrated in every text-book of physics, but not in sufficient detail to make clear its mechanism when used for medical purposes. Craving the indulgence of those who may be thoroughly informed on these points, and who may therefore regard as primitive the remarks that follow, let me, by the aid of the accompanying diagram (Fig. 1), describe the course and influence of the electric current in an ordinary separate coil faradic apparatus.

All induction machines are composed of not less than two coils. The first or primary coil consists of a large, well-insulated wire surrounding a bundle of soft iron wire,

which forms a magnetic centre. Over this first or primary coil is wound a coil composed of several convolutions of fine, well-insulated wire for the induced current.

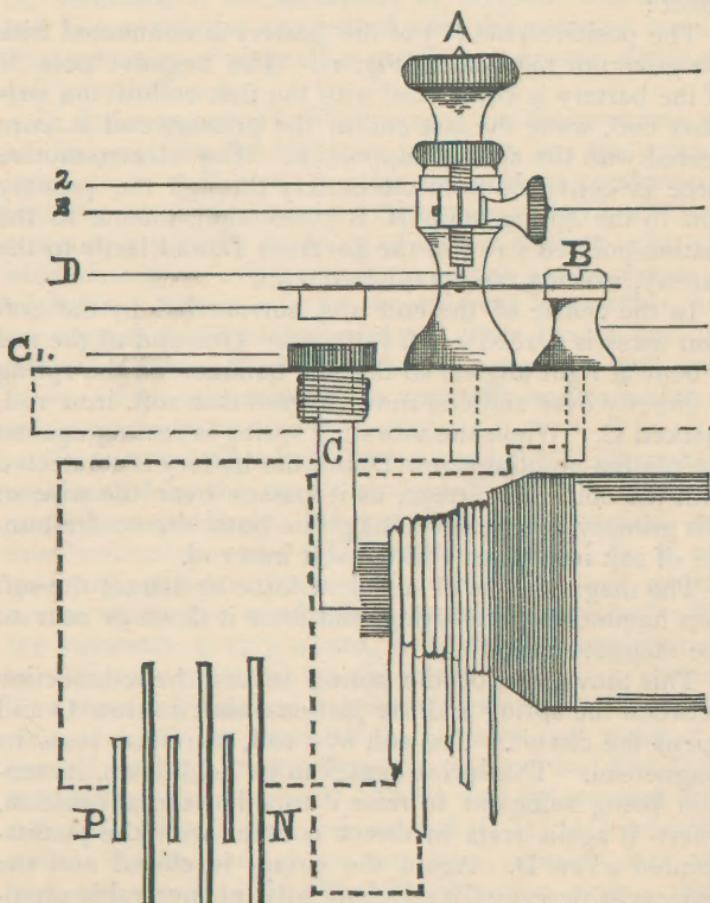


Fig. 1.

The terminals of the first or primary coils of wire are united, one end to the battery that operates the coil, and the other to the part of the automatic rheotome accord-

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ing to the following description. As the battery is *the* important factor, let us start from it and follow the connections and action of the combinations that produce the effect :

The positive pole (P) of the battery is connected with the governor marked A (Fig. 1). The negative pole N of the battery is connected with the first end of the primary coil, while the last end of the primary coil is connected with the spring support B. The electro-motive force is conveyed from the battery through the primary coil to the spring support B (rheotome), thence to the platina-pointed screw of the governor D, and lastly to the battery, making the complete circuit.

In the centre of the coil and surrounded by the soft iron wires is placed a soft iron rod. One end of the rod is bent at right angles, so that the hammer on the spring is directly over and can move toward this soft iron rod, marked C. When the vibrating spring is resting against the platina-pointed screw D and the battery is connected with the coil, the current, as it passes over the wire of this primary coil, renders magnetic both the centre bundle of soft iron wires and the soft iron rod.

The magnetism is of sufficient force to attract the soft iron hammer on the spring, and draw it down or near to the magnetized rod C.

This movement of the spring severs the connection between the spring and the platina-pointed screw D and opens the circuit. The soft iron rod, therefore, loses its magnetism. The spring ceases to be held down, its tension being sufficient to raise it to a horizontal position, where it again rests in direct contact with the platina-pointed screw D. Again the circuit is closed and the process as described is repeated with inconceivable rapidity. By the action of the battery current, as it is conveyed over the primary coil, and the influence of the magnetized bundle of soft iron wires, a current is induced upon the second coil of fine wire which surrounds the primary coil. This power of induction can be established to the

fifth and sixth coil, and further if the magnetic field is properly arranged.

In the ordinary form of induction coil just described, the terminals of the secondary or fine wire coil are free and in no manner connected with the primary circuit. The influence of magnetism produces a current which we call pure induced.

In the continuous coil apparatus, on the contrary, we not only receive the inductive influence, but the primary influence as well, since it is carried over in combination with the induced currents. Although called a continuous coil, it is really made up of several distinct coils, and each successive coil increases in length but decreases in thickness. These coils are wound over each other, and are tapped at different portions of their length, but, unlike other forms, they make direct connection with each other. This accounts for an apparent contradiction of terms that might prove confusing.

These coils (Fig. 2) are, for convenience of illustration, represented by the upper straight lines I, II, III, IV, termed, respectively, the primary, first, second, and third induction coils. The letters A, B, C, D, E represent the different posts of the continuous coil apparatus to which the conducting cords are attached, while the numerals 1, 2, 3, 4, etc., indicate the combinations by which are obtained ten different qualities of current. The short line marked 1, starting from A, represents the current from the short, thick, primary coil marked I. Second line (2), current from the primary and first (I, II) induction coils combined. Third line (3), current from the primary and first and second (I, II, III) induction coils. Fourth line (4), current from primary, first, second, and third (I, II, III, IV) induction coils. Fifth line (5), current from the first (II) induction coil only. Sixth line (6), current from the first and second (II, III) induction coils. Seventh line (7), current from the first, second, and third (II, III, IV) induction coils. Eighth line (8), current from the second (III) induction coil.

Ninth line (9), current from the second and third (III, IV) induction coils combined. Tenth line (10), current from the third (IV) induction coil only.

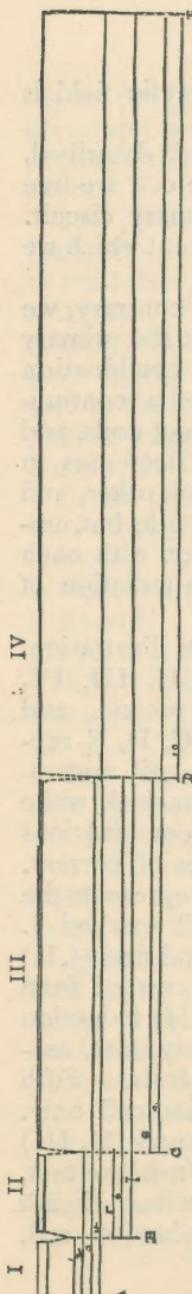
Therapeutical considerations.—When we consider the many combinations that are possible in the continuous coil apparatus and the different qualities of current that result therefrom, its general superiority over the separate coil is sufficiently evident; and this superiority becomes more marked if we examine into the varied physical and physiological effects produced by these combinations.

Our object of inquiry, however, is not as to the relative merits of different machines, but as to the comparative value of and the differential indications for the use of the various combinations of the continuous coil apparatus. This point of inquiry, although less important than when it relates to the two forms of dynamic electricity, is yet of no little account, and in some respects has been found to be more difficult of solution.

Notwithstanding the many qualities of current that are derived from the continuous coil, I have, after much observation, reduced to three the number of combinations that seem to be worthy of differential consideration.

Every therapeutic result that can be obtained by any of the ten combinations heretofore considered, will in all probability result from the use of some one of the following :

1. The current from the primary coil as represented by the line marked 1 (Fig. 2).



2. The current from the primary and the first and second induction coils in combination, as represented by the line marked 3.

3. The current from the primary and the first, second, and third induction coils in combination, as represented by the line marked 4.

The primary coil yields a current of large quantity but of small tension, owing to the fact that the wire of which the coil is composed is short and thick. It is worthy of note, however, that this current has considerable chemical power. It will burn iron or steel, giving forth a bright deflagrating spark, and will readily electro-plate, an effect not obtainable with any of the induction coils, either alone or in combination with each other. This current is apparently very weak, and induces but slight muscular contractions in the healthy person. In occasional pathological conditions, however, this mild current acts with unexpected energy, producing muscular contractions far exceeding in vigor those that are called forth by the stronger action of the induction coils.

On account of its mild but efficient action the current from the primary coil is preferable for applications to the head and the more sensitive portions of the body, and it will, as a rule, relieve pains of a true neuralgic character, and especially when great tenderness exists along the course of the nerve, far more effectually than the current from any of the induction coils. It is impossible to account for this frequently observed fact, without it be ascribed to a combination of the battery and the inductive influence. When dealing with an agent so subtle and so little understood as electricity, it is difficult to express one's meaning in terms altogether satisfactory, but that such a combination is active and effective is evidenced by the readiness with which electrolytic effects are produced. Asthenopia is a symptom that I have known to be greatly relieved and even cured many times by electricity, but more especially through the use of the primary coil. The tired, aching eye is both tempo-

rarily rested after each sitting and permanently strengthened by continued treatment. There seems to be little appreciation, either among ophthalmologists or general practitioners, of the great relief that may follow this treatment in the many cases where the eyes ache severely, if used even for a little time before breakfast or at twilight, or where neuralgic pains exist in or near the eye, or where there is annoyance from *muscae volitantes*.

As we include in the circuit with the primary the various induction coils, the current increases in strength with each coil that is added. With the addition of the first induction coil a much greater strength is apparent, but the combination has no marked physical or physiological effects that need detain us. By including also the second induction coil in the circuit, however (line marked 3, Fig. 2), we obtain a current of a peculiar and unique quality. Like the primary coil, it will electroplate, but unlike it, it will not burn steel or iron. The peculiarity of this combination of the coils is that the maximum of power to contract muscular tissue is here obtained. Each additional coil now that is attached simply gives a decreasing contractile power. Why the maximum of current strength is reached in the combination of the primary with the first and second induction coils it is difficult to say, excepting as we ascribe it to the law of harmony or polarization that is brought about by properly conditioning the magnetic centre of the helix, the several coils composing the helix, and the battery influence acting upon the coils. The current from this combination is not at all pleasant; it is keen and cutting in character, and with its strong contractile properties it is peculiarly adapted to those cases where powerful impressions are called for. Hence in not a few cases of paralysis where the response to galvanism is perfect, but where there is a diminution of farado-muscular contractility, I have found it preferable to any of the other qualities of current to be derived from the continuous coil apparatus.

In superficial forms of anaesthesia it is, perhaps, in no way superior, but in certain persistent and more deeply seated forms of lost or perverted sensibility it is decidedly more efficacious than other combinations. Its greater contractile power over muscular tissue, both voluntary and involuntary, renders it more efficacious in cases of menstrual suppression, and also for atrophied conditions of the uterus, for which so much has been done by electrical methods of treatment. In cases of dysmenorrhœa, as well as in the various neuralgias, my experience leads me to exclude its use. Faradism has been used, and with success, to destroy the foetus in extra-uterine pregnancy. While I greatly prefer the galvanic current, having always used it without the slightest ill effect, yet if the faradic is employed I should not recommend the current from the coils now under consideration, but the one presently to be described; for with this latter form we obtain effects equally destructive to the foetal life and with less violence to the contractile tissues of the mother. There are several other differential points connected with the use of this series which suggest themselves, but they are of minor importance.

One other condition, however, deserves mention. Impaired virility is a defect for which relief is very often sought. Its influence upon the mind is most unfortunate, and it should be understood that electricity is often of very considerable benefit in these cases. It is sufficient to say that no case which is in any way hopeful should be abandoned until the current from the primary and first and second induction have been tried.

When we include in the circuit not only the primary and the first and second, but also the third induction coil as represented by the line marked 4, effects are obtained more interesting and satisfactory than from any of the other combinations.

These effects are pre-eminently tonic and sedative in character, and give for this quality of current a range of usefulness wider than can be ascribed to the others.

There are but few, in all probability, who at this day are unfamiliar with the term general faradization, and who do not understand that by it is meant the application of the faradic current to the entire surface of the body, from the crown of the head to the soles of the feet. It is in the operation of general faradization, when we desire to obtain the best constitutional tonic effect that electricity is capable of giving, that we resort to this combination of the primary and induction coils. Its action on the motor and sentient nerves is less severe, and its general effects far more agreeable. For the relief of that great army of symptoms that are so familiar and so perplexing to those who have had much to do with neurasthenic cases, there is, according to my experience, nothing to be compared with it. Even the galvanic current by the method of central galvanization, so important in its direct effect upon the central nervous system, falls short of the therapeutic results that follow well-directed applications of general faradization. When persistent failure follows endeavors along this line of electrization, the cause of failure must be ascribed to hasty and faulty methods of administration. In no department of therapeutics is it of more importance to be thorough in detail. He only will achieve the best results who appreciates this fact, who is willing to inform himself as to the *modus operandi* of the methods, and who will devote in individual cases a reasonable degree of time and patience in carrying them out.

